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Exploring Complex-Langevin Methods for Finite-Density QCD

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Recent advances in applying complex-Langevin simulations to gauge theories with complex actions, in particular gauge-cooling, have revived interest in using these methods for QCD at finite baryon-number density. QCD at a finite chemical potential μ for quark number has a complex fermion determinant which prevents use of standard simulation techniques. Complex-Langevin simulations show promise for simulating this theory. We describe our preliminary investigations in applying complex-Langevin simulations to lattice QCD at finite μ . We use a complex extension of the partial second-order approach to Langevin simulations of Fukugita, Ukawa and others, using staggered fermions. Our current studies are of 2-flavour lattice QCD at finite μ at zero temperature on a 12^4 lattice. Of special interest is if we can observe the expected transition at $\mu \approx m_N/3$, and whether there is a spurious transition at $\mu \approx m_\pi/2$. Finite-temperature simulations at finite μ are also planned.

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